PhD scholarship

Title	Experimental study of the coupling between inertial particles and the wake of an Ahmed body: application to vehicle aerodynamics under heavy rain.
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Locations	**Laboratoire LEGI** UGA/G-INP 1209-1211 Rue de la Piscine 38400 Saint Martin d'Hères https://www.legi.grenoble-inp.fr/web/ Laboratoire LMFL, Kampé de Fériet Batiment M6, Blv Langevin, Cité scientifique F-59655 Villeneuve d'Ascq https://lmfl.cnrs.fr/
Duration	36 months full-time, starting Fall 2025

Context and motivation:
To promote the development of environmentally friendly transportation, the advancement of technological innovations is essential. This includes the development of new propulsion systems (hybridization, e-fuel, etc.) as well as improvements in vehicle aerodynamics, which significantly impact energy consumption. Over recent decades, the scientific community has made considerable efforts to control road vehicle aerodynamics to enhance performance. While progress has been made, almost all these **studies neglect the influence of environmental conditions on aerodynamics**. Recent studies [1,2] highlight the importance of atmospheric conditions (ambient turbulence, rain, etc.) for accurately predicting aerodynamic performance. These results show that **current knowledge about road vehicle aerodynamics is only partially applicable to real-world driving conditions**.

This PhD thesis aims to address the aerodynamic behaviour of a model road vehicle (Ahmed body type) in ambient flow conditions representative of real driving scenarios. The objectives are to study in detail the single-phase flow around an Ahmed body under various experimental conditions to quantify the effects of Reynolds number and realistic climatic conditions (active-grid-generated turbulence in a wind tunnel). Experiments will use optical instrumentation such as LDV and PIV, and hot-wire anemometry for near-wall velocity characterization. The aerodynamic performance of the model vehicle will also be measured (aerodynamic forces and surface pressure field). The second part of the study will focus on characterizing the flow in the presence of inertial particles (raindrops) using a Phase Doppler Interferometer (PDI). It aims to highlight performance changes due to raindrops and their impact on flow topology. Additionally, to decouple the different phenomena, surface alterations from raindrop impacts will be simulated. A measurement campaign

will provide roughness models, which will be implemented on the Ahmed body and tested in a wind tunnel at the PRISME laboratory.

Work environment:
The recruited candidate will join the EDT (Two-Phase and Turbulent Flows) team at LEGI, University Grenoble Alpes. Extended research stays at LMFL-Lille are also planned. The work will focus on an experimental approach to studying turbulent flows with or without inertial particles [3,4]. The studies will be conducted in large wind tunnels at LEGI and LMFL, equipped with advanced metrology tools. Additional collaborations will occur with PRISME laboratory at the University of Orléans, a partner in the national collaborative project funded by the French National Research Agency (ANR TWIN ANR-24-CE51-4987), led by LEGI. Strong interactions with project partners will provide a scientifically rich environment.

Required skills:
We seek a highly motivated individual with a Master's degree or engineering diploma and strong knowledge in fluid mechanics or physics and instrumentation. The candidate should be keen on experimental research and proficient in post-processing tools (e.g., Matlab, Python). The candidate will be actively involved in disseminating results through progress reports, peer-reviewed publications, and international conferences. Strong communication and writing skills in both English and French are required.

Salary
Gross salary: approx. €24,500/year including social security contributions.
PhD contract expected to begin in October 2025.

Application procedure

- Curriculum Vitae
- Cover Letter
- Transcript (even preliminary) of the last two academic years
- Contact information for two academic referees

Send applications to Henda DJERIDI and Bertrand MERCIER (henda.djeridi@legi.grenoble-inp.fr , bertrand.mercier@univ-grenoble-alpes.fr) and Martin OBLIGADO (martin.obligado@centralelille.fr) before 01/07/2025.

References

[1] Mazellier, N., & Obligado, M. (2023). Aerodynamics of the square-back Ahmed body under rainfall conditions. Europhysics Letters, 144(1), 13001.
[2] Smith, S. E., Travis, K. N., Djeridi, H., Obligado, M., & Cal, R. B. (2021). Dynamic effects of inertial particles on the wake recovery of a model wind turbine. Renewable Energy, 164, 346-361.
[3] Smith, S. E., Djeridi, H., Calaf, M., Cal, R. B., & Obligado, M. (2023). Particle transport-driven flow dynamics and heat transfer modulation in solar photovoltaic modules: Implications on soiling. Solar Energy, 265, 112084
[4] Mercier B., Thomas L., Tremblais B., David L. A robust pairing method for two-pulse particle tracking velocimetry based on coherent point drift. Measurement Science and Technology, Vol 35 N° 6, 2024